Emotion recognition in face and body motion in Bulimia Nervosa

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ABSTRACT

Social cognition has been studied extensively in anorexia nervosa (AN), but there are few studies on this topic in bulimia nervosa (BN). This study investigated the ability to recognise emotions in ambiguous facial expressions and in body movement in people with BN. Participants were 26 women with BN, who were compared to 35 with AN, and 42 healthy controls (HC). Participants completed an emotion recognition task using faces portraying blended emotions, along with a body emotion recognition task using videos of point-light walkers. The results indicated that BN participants exhibited difficulties recognising disgust in less-ambiguous facial expressions, and a tendency to interpret non-angry faces as anger. These difficulties were similar to those found in AN. There were no significant differences amongst the groups in body motion emotion recognition. The findings suggest difficulties in disgust and anger recognition in facial expressions that may be shared transdiagnostically in people with eating disorders.

Keywords: social cognition, emotion recognition, face, body, eating disorders

INTRODUCTIONS AND AIMS

People with eating disorders (ED) may exhibit difficulties in social cognition (Caglar-Nazali et al., 2014), the mental processes that underlie social behaviour (Adolphs, 1999). A range of types of social cognition functions may be affected, including the ability to interpret social signals such as facial expressions and body movements.

Emotion recognition in facial expressions has been studied extensively in people with anorexia nervosa (AN), and studies looking at the ability to recognise basic emotions have tended to show difficulty in specific emotions such as sadness and disgust (Tchanturia, Dapelo, Harrison, & Hambrook, 2015). In contrast, only a handful of studies have explored basic emotion recognition in people with bulimia nervosa (BN). Studies using combined samples of BN and AN participants have provided dissimilar findings, reporting generalised difficulties recognising emotions in adolescents (Zonnevijlle-Bender, van Goozen, Cohen-Kettenis, van Elburg, & van Engeland, 2002), but no difficulties in adults with ED (Cardi et al., 2015). On the other hand, studies carried out in participants with BN only, generally report difficulties recognising specific emotions. For example, two studies have found slight difficulties recognising surprise in people with BN (Kessler, Schwarze, Filipic, Traue, & von Wietersheim, 2006; Legenbauer, Vocks, & Ruddel, 2008), and one study found difficulties recognising anger, which tended to be misinterpreted as fear or a neutral state (Kuhnpast, Gramann, & Pollatos, 2012), but no problems recognising other emotions.

It has been proposed that properties of the stimuli used in emotion recognition tasks may influence performances (Kuhnpast et al., 2012). Most of the previous studies have used images of faces depicting prototypical expressions of emotions. Instead, real-life expressions are usually ambiguous and may involve blended emotions (Buisine et al., 2006), which can be more challenging to interpret, but more naturalistic. There is preliminary evidence of poorer performance in subtle displays of emotions in non-clinical participants with disordered eating behaviour (Ridout, Wallis, Autwal, & Sellis, 2012), but the ability to recognise emotions in ambiguous, blended facial expressions in people with BN diagnosis has not been studied.

In addition to facial expressions, another source of information about people's emotions is body language (App, McIntosh, Reed, & Hertenstein, 2011). It has been shown that specific emotional states can be inferred by observing particular body movements (Atkinson, Dittrich, Gemmell, & Young, 2004; Demeijer, 1989; Heberlein, Adolphs, Tranel, & Damasio, 2004), and there is evidence that particular patterns of body movements may be specific to certain emotions (Wallbott, 1998). However, no study has investigated body emotion recognition in people with BN.

In previous studies, we have investigated the ability to recognise emotions in blended facial expressions and in body motion in participants with AN (Dapelo et al., 2015; Lang et al., 2015). The current study aimed to extend this research to people with BN, comparing their performance to an AN group and healthy individuals.

METHOD

Participants

Twenty six adults with BN participated in the study, and were compared to 35 AN, and 42 healthy controls (HC) whose data has been reported previously (see Dapelo, Surguladze, Morris, & Tchanturia, 2016; Lang et al., 2015)[1]. All samples included only women. Participants with ED were recruited from specialist ED services and through advertisement on the UK 'Beat' charity website (http://www.b-eat.co.uk/). HC participants were recruited from the university and local community. The Structured Clinical Interview for DSM-IV (SCID-I) (First, Gibbon, Spitzer, & Williams, 2002) was used to assess current and past ED diagnosis according to DSM-5 (American Psychiatric Association, 2013) in all participants. A BMI of 18.5 $kg.m^2$ was used as a threshold for AN diagnosis. Exclusion criteria were presence of head injury, autistic spectrum disorders, psychosis, not being fluent in English, or inability to provide informed consent. Participants were compensated for their participation with £10.

Measures

[1] The AN and HC participants are a subgroup of the sample reported in Lang et al., 2015, which included adult and adolescent participants.

Body Mass Index (BMI): This was determined by measuring participants' height and weight of on the assessment day.

Structured Clinical Interview for DSM-IV-TR Axis I Disorders; SCID-I (First et al., 2002): The ED module of the SCID-I was used to assess current and past ED diagnosis. To adjust the interview to DSM-5, a frequency of binge eating and purging behaviour of once a week was used for BN diagnosis, and amenorrhea was not required for AN diagnosis.

Eating Disorder Examination Questionnaire; EDE-Q (Fairburn & Beglin, 1994): This is a 36-item self-report measure with 4 subscales (restriction, eating concern, shape concern, and weight concern) and a global score, widely used to evaluate ED.

Hospital Anxiety and Depression Scale; HADS (Zigmond & Snaith, 1983): This 14-item self-report questionnaire has two subscales evaluating anxiety and depression.

Facial emotion recognition task

The task used in the study has been described in detail (Dapelo et al., 2016). The expression were taken from the Facial Expressions of Emotion: Stimuli and Test (FEEST) set of morphed facial expressions (Young, Perret, Calder, Sprengelmeyer, & Ekman, 2002), in which blended emotions were generated by morphing prototypical expressions using pairs of basic emotions (i.e., happiness-fear, happiness-sadness, happiness-disgust, happiness-anger, fear-sadness, fear-disgust, fear-anger, sadness-disgust, sadness-anger, and disgust- anger). For each pairing there were five proportions (e.g. for happiness and fear these were 90% happiness and 10% fear, 70% happiness and 30% fear, 50% happiness and 50% fear, 30% happiness and 70% fear, and 10% happiness and 90% fear). In all, 100 faces were generated and presented 3 times in random order. Each face was accompanied by 5 labels (i.e., anger, disgust, fear, happiness and sadness) and participants were requested to select the emotion that best described the facial expression shown.

To evaluate emotion recognition accuracy, the percentage of correct response was obtained for each emotion at 90% (i.e., 90:10), and 70% (i.e., 70:30) proportion. For example, in order to calculate the results for happiness at 90%, the times the participant selected 'happiness' for all facial expressions

containing happiness at 90% (i.e., 90% happiness and 10% of either fear, sadness, disgust or anger) was recorded and the percentage was calculated. Since the pictures depicting emotions at 50% (i.e., 50:50) have two 'correct' answers, the percentage of responses for both 'correct' answers was considered. For example, in a facial expression showing 50% happiness and 50% fear, both emotions were considered 'correct' (Humphreys, Minshew, Leonard, & Behrmann, 2007).

To evaluate response bias scores, the times a participant selected an 'incorrect' response was recorded and the percentage was calculated. For example, in order to calculate the response bias towards happiness at 90%, the percentage of times the participant selected the 'happiness' answer choice to all 90% facial expressions that did not contain happiness was recorded (Isaacowitz et al., 2007).

Body motion emotion recognition task. Point-light walkers (PLW):

This task has been described previously (Lang et al., 2015). Stimuli were 40 video clips of point-light walkers that were developed by filming actors walking from left to right, whilst portraying one of four emotions (anger, fear, happiness, or sadness) or an emotionally neutral state (Atkinson, Heberlein, & Adolphs, 2007). The actors were filmed in the dark and had small lights attached to their joints. Thus, the stimuli appear as white dots on a dark background (Atkinson et al., 2004). As in the facial emotion recognition task, participants had to select the emotion that they thought best described the movements shown from 5 alternatives (angry, afraid, happy, sad, or neutral).

To evaluate emotion recognition accuracy, a proportional correct scoring method suggested for stimuli of this kind (Heberlein et al., 2004) was employed as follows: The stimuli were piloted in 15 healthy individuals, forming a reference sample. For this reference group, percentages were calculated for the times each clip was labelled with a specific emotion, and this data was used for the proportional scoring. For example, if a clip was labelled as 'happy' by 70% of the reference group, 'angry' by 20% of the reference group, and 'sad' by 10% of the reference group, then if participants labelled the same stimulus as 'happy' they would achieve the highest score of 1.0 (0.7/0.7), if they labelled it as 'angry' they would receive a score of 0.28 (0.2/0.7), and if they labelled it as 'sad' they would receive a score of 0.14 (0.1/0.7). All other answers would receive a score of 0.

Procedures

Participants attended one session in which they signed informed consent and all self-report and experimental measures were carried out. The study was approved by the NHS Research Ethics Committee, reference number 13/LO/0201.

Statistical Analysis

Data were analysed using SPSS version 24. Normality was examined using the Shapiro-Wilk test. Data were not normally distributed, thus the non-parametric Kruskal Wallis test was used to evaluate group differences. Mann Whitney U test was used for pairwise post-hoc comparisons, with Rosenthal's *r* effect size for non-parametric test. Bonferroni correction for multiple testing was applied, setting $\alpha < 0.016$.

RESULTS

Demographics and Clinical Characteristics

Participants' demographic and clinical characteristics are presented in Table 1.

At the time of the study the majority of AN participants were receiving inpatient treatment (n=15), followed by outpatient (n=9), intensive outpatient treatment (such as day care) (n=8), and self-help (n=1). Only two AN participants were not receiving treatment. Most of the BN participants were receiving outpatient treatment (n=12), followed by self-help (n=2) and intensive outpatient (n=1). Eleven BN participants were not receiving treatment. Thirteen BN participants had met criteria for AN diagnosis in the past.

----- Insert Table 1-----

Facial emotion recognition

Emotion recognition accuracy

Table 2 shows the percentage of correct responses for emotions depicted at 90%. Results indicated significant differences amongst groups for disgust recognition ($H(2)=14.34$; $p<0.01$). Post-hoc

analysis showed that participants with AN and with BN had significantly lower percentage of correct responses for disgust recognition, when depicted at a proportion of 90%, compared to HC (ANvsHC: U=410.00; p<0.01; r=0.39; BNvsHC= U=330.50; p<0.01; r=0.34). There were no statistically significant differences between participants with AN and those with BN (ANvsBN: U=375.50; p=0.24). Further examination of the responses through a confusability matrix showed that most of the BN participants who did not recognise disgust misinterpreted it as anger (Confusability matrix can be found in Table S1).

There were no other statistically significant differences amongst groups (Anger: H(2)=0.39; p=0.82; Fear: H(2)=5.23; p=0.07; Happiness: H(2)=0.57; p=0.75; Sadness: H(2)=0.38; p=0.83).

--- Insert Table 2 ----

Percentage correct responses for emotions at 70% and 50% can be found in Table S2. Group comparisons yielded no statistically significant differences amongst groups in emotion recognition accuracy with these stimuli. (*Emotions at 70%:* Anger: H(2)=3.34; p=0.19; Disgust: H(2)=3.05; p=0.22; Fear: H(2)=0.85; p=0.65; Happiness: H(2)=2.88; p=0.24; Sadness: H(2)=0.14; p=0.93; *Emotions at 50%:* Anger: H(2)=0.86; p=0.65; Disgust: H(2)=0.56; p=0.76; Fear: H(2)=2.10; p=0.35; Happiness: H(2)=1.74; p=0.42; Sadness: H(2)=1.68; p=0.43).

Response bias

Table 2 shows the results for response bias in emotions depicted at 90%. Results showed significant differences amongst groups, indicating a response bias towards anger (H(2)=12.38; p<0.01). Post-hoc results showed that participants with AN and with BN had significantly higher preference to interpret non-angry faces as anger, compared to HC (ANvsHC: U=433.50; p<0.01; r=0.36; BNvs.HC= U=345.00; p<0.01; r=0.32). There were no statistically significant differences between participants with AN and those with BN (ANvsBN: U=384.00; p=0.30)

Response bias results for emotions at 70% and 50% can be found in Table S3. Group comparisons showed no statistically significant differences amongst groups, indicating no evidence of response bias. (*Emotions at 70%:* Anger: H(2)=2.79; p=0.25; Disgust: H(2)=2.56; p=0.28; Fear: H(2)=4.83;

p=0.09; Happiness: H(2)=0.41; p=0.82; Sadness: H(2)=1.18; p=0.56; *Emotions at 50%:* Anger: H(2)=1.26; p=0.53; Disgust: H(2)=0.21; p=0.90; Fear: H(2)=0.27; p=0.87; Happiness: H(2)=0.00; p=1.00; Sadness: H(2)=0.14; p=0.94).

Body motion emotion recognition

Five participants with AN and two with BN did not complete the PLW task due to lack of time. Therefore, the number of participants per group for this task was 30 AN, 24 BN, and 42 HC.

Participants' scores for each emotion and neutral can be seen in Table 3. There were no statistically significant differences amongst groups (Anger: H(2)=0.02; p=0.99; Fear: H(2)=0.35; p=0.84; Happiness: H(2)=4.24; p=0.12; Sadness: H(2)=0.75; p=0.69; Neutral: H(2)=0.54; p=0.76).

---- Insert Table 3-----

DISCUSSION

In recent years there has been an increased interest in investigating social cognition in people with ED. However, compared to the literature on emotion recognition in people with AN, research in BN individuals is uncommon (Dejong et al., 2013). This study investigated emotion recognition from faces and body motion in women with BN, compared to those with AN and to HC. The results showed that, compared to HC, BN participants had difficulties recognising facial disgust when depicted in a less ambiguous fashion (i.e., in facial expressions that showed disgust at a 90% proportion), and tended to misinterpret it as anger. In addition, the results from the response bias analysis indicated that BN participants tended to interpret non-angry faces as anger. There were no differences between BN and AN participants. These findings are in agreement with previous studies in BN participants showing difficulties recognising a specific emotion in facial expressions, but no global impairment. However, previous studies reported difficulties in other emotions, specifically in surprise (Kessler et al., 2006; Legenbauer et al., 2008) and anger (Kuhnpast et al., 2012). Thus, the evidence of difficulties recognising disgust in BN is novel.

The findings show similarities in emotion recognition in BN and AN participants. This is in line with previous evidence of shared difficulties in socio-emotional functioning in BN and AN, including high levels of social anhedonia (Harrison, Mountford, & Tchanturia, 2014), attentional bias towards angry and rejecting faces (Cardi, Di Matteo, Corfield, & Treasure, 2013; Harrison, Sullivan, Tchanturia, & Treasure, 2010), and avoidance of accepting and compassionate faces (Cardi et al., 2013).

It has been suggested that similar neural regions are implicated in social cognition in people with BN and AN (McAdams & Krawczyk, 2013). Thus, the study findings may reflect similarities in neural processing for both groups. It has been proposed that emotion processing difficulties in people with AN could be explained by a dysfunction of the insula (Nunn, Frampton, Gordon, & Lask, 2008), which is the brain region implicated in the processing of disgust (Phillips et al., 1997). Altered function of the insula has been shown in BN participants in response to sweet tastes (Oberndorfer et al., 2013), but not in response to disgusted facial expressions (Ashworth et al., 2011). Therefore, it is unclear whether a dysfunction of the insula could explain the difficulties in disgust processing shared by participants with BN and AN in this study.

In addition to facial recognition accuracy, the study investigated response bias. The results showed a response bias towards anger in less ambiguous facial expressions. These findings may relate to attentional bias towards angry faces exhibited by people with ED (Cardi et al., 2013; Harrison et al., 2010), which could result in more attention to be paid to muscular actions that anger shares with disgust, such as brow lowering (Gery, Miljkovitch, Berthoz, & Soussignan, 2009).

The confusion between disgust and anger exhibited by BN participants in this study may also be indicative of more general difficulties the processing of these two emotions. It has been theorised that people with ED tend to inhibit emotions that are seen as unacceptable, such as anger, and replace them by more acceptable ones, such as disgust (Fox & Froom, 2009). In support to this theory participants with disordered eating behaviours, including BN features such as bingeing and purging, exhibited high sensitivity to disgust after an angry mood induction (Fox & Harrison, 2008). It may be that, as a result of this emotion coupling, people with BN have difficulties distinguishing disgust and anger.

This study also explored emotion recognition in body motion in people with BN. Results indicated that both participants with BN and AN did not differ from HC in their ability to recognise emotions from body movements. If the difficulties recognising emotions in people with ED are limited to disgust recognition, then the lack of differences found in this task could be due to a lack of clips depicting disgust. An alternative explanation might be that task used clips in which emotions were exaggerated (Atkinson et al., 2004), which could have obscured difficulties recognising more subtle expressions.

The similarities in the performance of BN and AN participants in this study may suggest that problems in emotion recognition are transdiagnostic in ED. However, it is worth noting that a half of the participants in the BN group had a past history of AN. Thus, the similarities in emotion recognition could be due to features that existed previously in this subgroup. Despite the well-known evidence of crossover between BN and AN diagnosis (Anderluh, Tchanturia, Rabe-Hesketh, Collier, & Treasure, 2009; Eddy et al., 2008), social cognition studies rarely assess past AN diagnosis in BN samples. Future studies with larger sample of BN participants could explore whether past AN diagnosis may explain shared difficulties in social cognition.

This study has some limitations. First, as indicated, the sample size for the BN group precluded further subgroup analyses. In addition, results from the body emotion recognition task were negatively skewed, which suggests a ceiling effect in which the task complexity may be not high enough to capture difficulties.

In conclusion, results from this study suggest a generally preserved ability to recognise emotions in people with BN. Nevertheless, the study findings indicate subtle difficulties recognising disgust, and a response bias towards anger when recognising emotions in the face. The similarities in the performance of BN and AN participants may suggest that problems in emotion recognition are transdiagnostic in ED.

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Table 1. Demographic and clinical characteristics.

	AN (n=35) Mean (SD)	BN (n=26) Mean (SD)	HC (n=42) Mean (SD)	Group Comparison F (p)	Tukey HSD Post hoc test (*)
Age	27.54 (8.36)	26.42 (6.53)	26.98 (7.55)	0.164 (0.85)	*n.a.*
BMI	15.33 (1.74)	21.74 (2.88)	22.53 (2.63)	93.47 (<0.01)	AN<BN; AN<HC
Length of illness (years)	10.54 (9.16)	7.73 (6.50)	*n.a.*	1.33 (0.19) **	*n.a.*
EDE-Q Restriction	4.17 (1.53)	3.55 (1.48)	0.59 (0.69)	91.01 (<0.01)	HC<AN; HC<BN
EDE-Q Eating Concern	3.83 (1.43)	3.57 (1.46)	0.15 (0.16)	127.85 (<0.01)	HC<AN; HC<BN
EDE-Q Shape Concern	4.81 (1.31)	4.49 (1.25)	0.92 (0.78)	143.86 (<0.01)	HC<AN; HC<BN
EDE-Q Weight Concern	4.23 (1.43)	4.20 (1.44)	0.57 (0.62)	121.15 (<0.01)	HC<AN; HC<BN
EDE-Q Global	4.26 (1.20)	3.95 (1.29)	0.56 (0.49)	159.39 (<0.01)	HC<AN; HC<BN
HADS Anxiety	13.49 (3.38)	12.08 (2.81)	5.79 (1.96)	86.29 (<0.01)	HC<AN; HC<BN
HADS Depression	10.31 (3.52)	9.27 (3.50)	3.74 (1.29)	59.69 (<0.01)	HC<AN; HC<BN

AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; F= ANOVA test; p= Statistical significance; n.a.= Not applicable; BMI= Body mass index; EDE-Q= Eating disorders examination questionnaire; HADS= Hamilton anxiety and depression scale.

*Only significant differences shown (α<0.016)

**T test results

Table 2. Facial emotion recognition and response bias for emotions at 90%.

	Percentage of correct responses					
	AN (n=35)		BN (n=26)		HC (n=42)	
	Mean (SD)	Mdn (IQR)	Mean (SD)	Mdn (IQR)	Mean (SD)	Mdn (IQR)
Anger	87.02 (14.57)	91.67 (16.67)	84.94 (15.37)	87.50 (25.00)	86.71 (14.08)	91.67 (17.71)
Disgust	76.31 (23.43)	79.17 (37.50)	86.38 (12.94)	89.58 (16.67)	92.96 (11.55)	95.83 (8.33)
Fear	94.29 (17.97)	100.00 (4.17)	97.28 (7.81)	100.00 (0.00)	99.11 (2.17)	100.00 (0.00)
Happiness	99.17 (3.62)	100.00 (0.00)	98.88 (4.18)	100.00 (0.00)	98.91 (4.02)	100.00 (0.00)
Sadness	96.79 (7.08)	100.00 (4.17)	97.28 (6.23)	100.00 (1.04)	98.31 (3.06)	100.00 (4.17)
	Response bias					
Anger	6.61 (9.45)	3.13 (9.38)	3.49 (4.24)	2.08 (4.17)	1.71 (2.77)	1.04 (2.08)
Disgust	2.44 (4.10)	1.04 (3.13)	2.84 (3.58)	1.56 (4.43)	1.09 (1.61)	0.52 (1.04)
Fear	1.90 (2.08)	1.04 (3.13)	1.96 (2.94)	1.04 (2.34)	2.70 (3.15)	2.08 (3.39)
Happiness	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
Sadness	0.65 (1.21)	0.00 (1.04)	0.52 (0.85)	0.00 (1.04)	0.50 (1.18)	0.00 (0.26)

AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; Mdn= Median; IQR= Interquartile range.

Table 3. Body motion emotion recognition

	AN (n=30)		BN (n=24)		HC (n=42)	
	Mean (SD)	Mdn (IQR)	Mean (SD)	Mdn (IQR)	Mean (SD)	Mdn (IQR)
Anger	7.54 (0.81)	8.00 (0.95)	7.60 (0.57)	8.00 (0.93)	7.56 (0.66)	8.00 (1.00)
Fear	7.12 (0.96)	7.16 (1.53)	7.25 (0.84)	7.25 (0.98)	7.25 (0.79)	7.25 (1.00)
Happiness	6.42 (1.11)	7.00 (1.23)	6.79 (0.77)	7.00 (1.06)	6.94 (0.71)	7.00 (1.11)
Sadness	6.95 (1.41)	7.22 (1.64)	6.70 (1.34)	7.00 (2.43)	6.87 (1.32)	7.04 (1.64)
Neutral	6.77 (1.36)	7.00 (2.00)	7.04 (1.12)	7.00 (2.00)	6.93 (1.00)	7.00 (2.00)

AN=Anorexia nervosa; BN= Bulimia nervosa; HC= Healthy controls; SD= Standard deviation; Mdn= Median; IQR= Interquartile range.